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GB 2292571 A US 5575336 A

(58) Field of Search

UK CL (Edition P ) E1F FJB FJC FJR FLE  
INT CL<sup>6</sup> E21B 33/04 33/043 34/04  
WPI

(54) Abstract Title

Annulus porting of horizontal tree

(57) A horizontal tree 11 has a vertical bore 13 and a horizontal production passage 19 and is landed in a wellhead housing. A tubing hanger 21 lands in the bore and has a vertical passage 25 and a horizontal passage 27 that aligns with that of the tree. A retrievable first plug 29 seals the vertical passage. A tree cap 37 seals in the tree bore above the tubing hanger via seals 49, 50 and has an axial passage 45. A retrievable second crown plug 51 seals the tree cap passage. A vent port to (Fig 2) extends laterally through the tree cap between its axial passage and outer surface. A pair of seals 58, 60 on the second plug seal above and below the vent port. A tubing annulus passage 83, 85 communicates with the vent port and an annulus passage 81. The second plug serves as a second pressure barrier to the first plug and blocks the vent port. The annulus passage is sealed from communication with a void between the plugs.

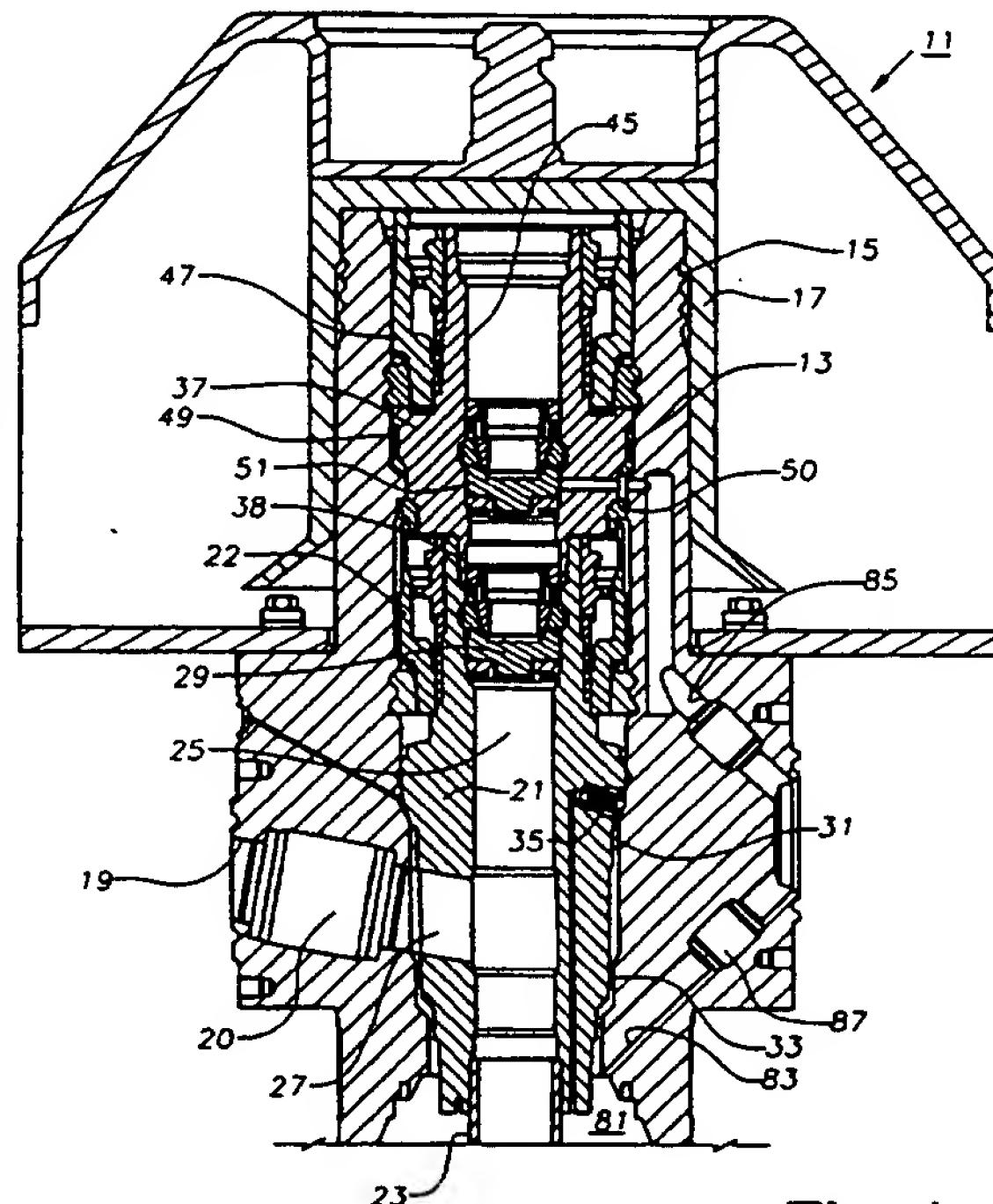


Fig. 1

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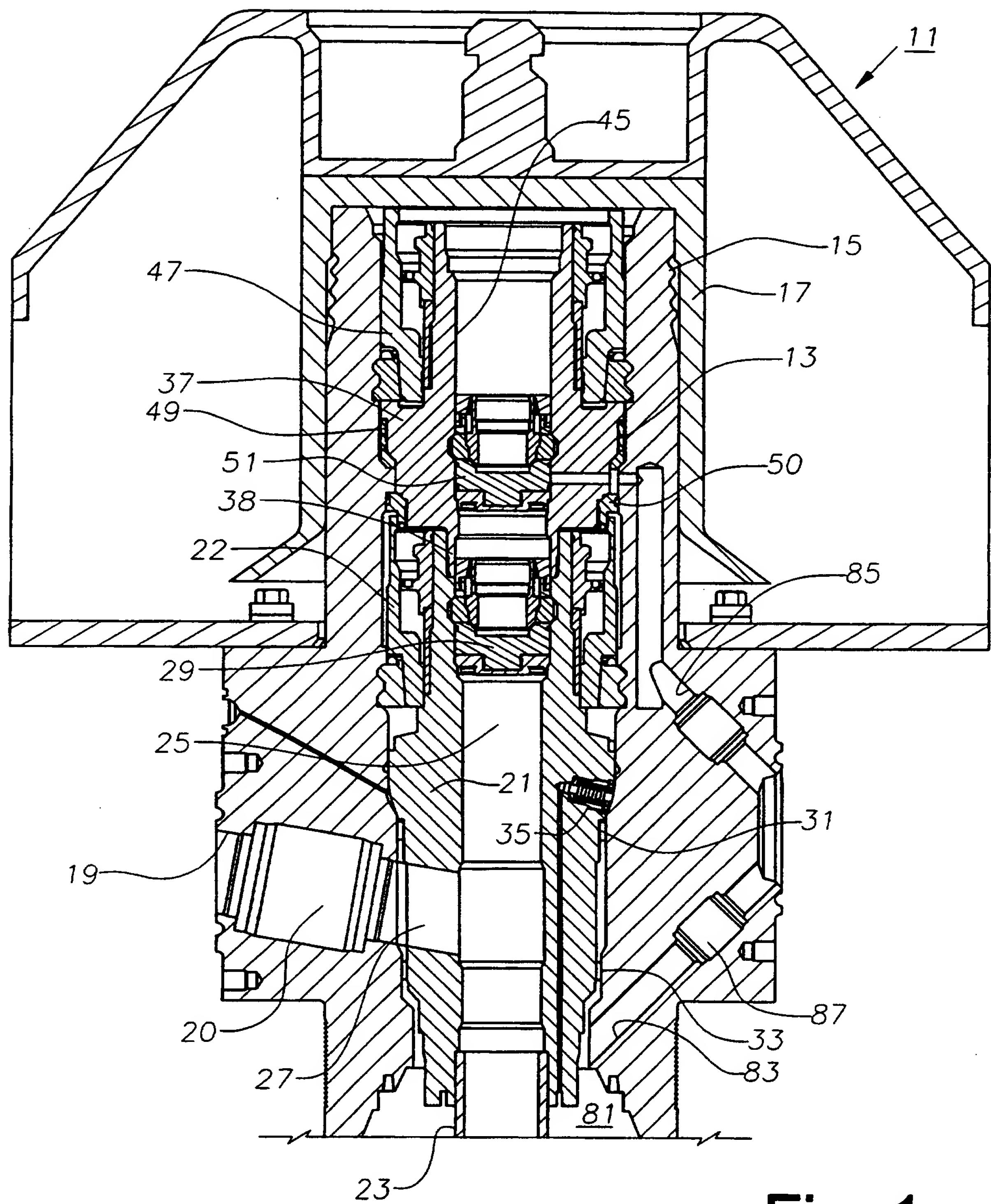


Fig. 1

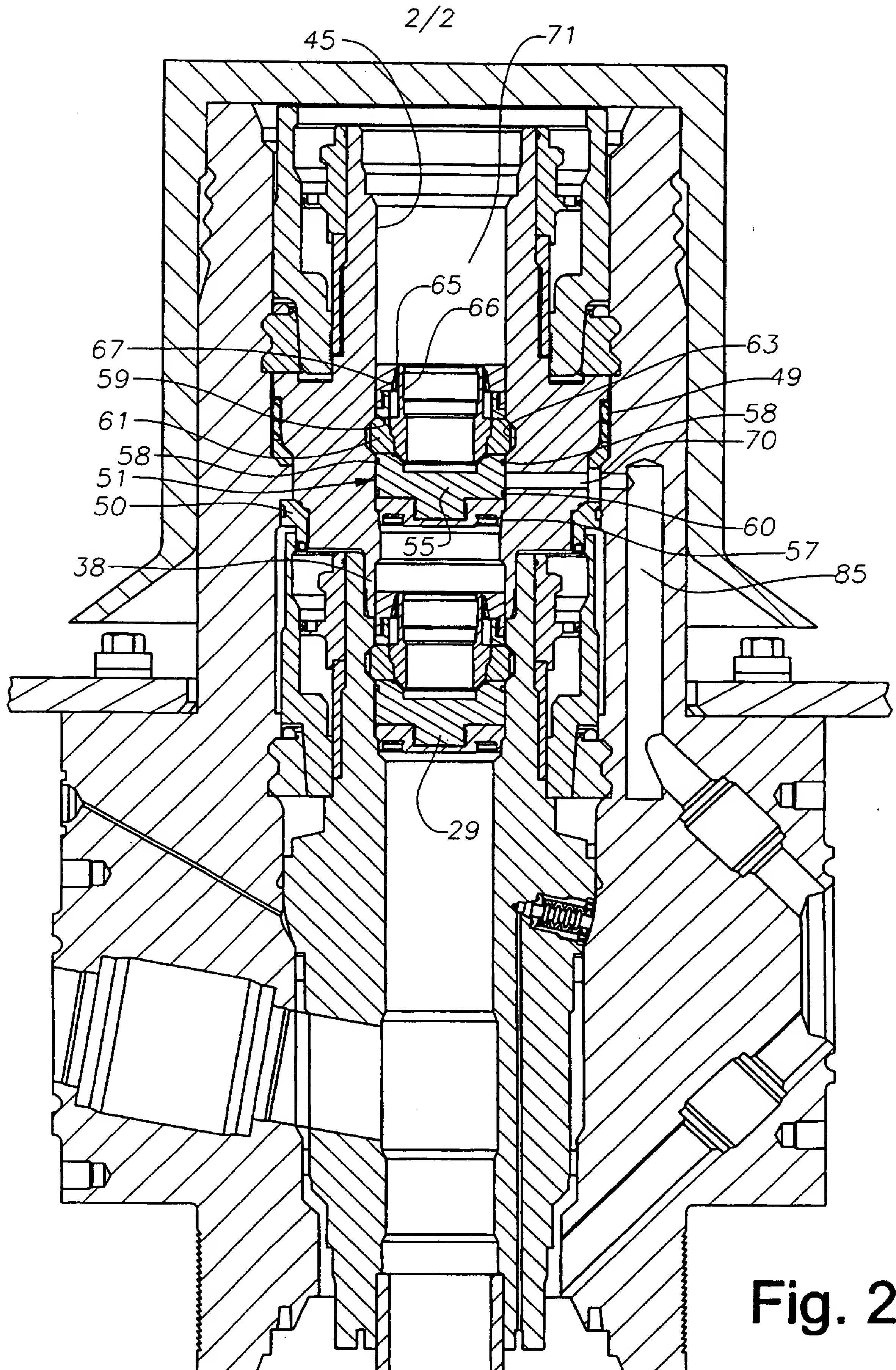


Fig. 2

1 Docket No. 174-96056  
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6                   **ANNULUS PORTING OF HORIZONTAL TREE**  
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10  
11                  INVENTOR: Lionel J. Milberger  
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16                  Technical Field  
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18                  This invention relates in general to oil and gas  
19                  well Christmas trees, and in particular to a tree cap for  
20                  a horizontal tree.  
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17                  Background Art  
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20                  One type of wellhead assembly, particularly used  
21                  offshore, is known as a horizontal tree. The well has a  
22                  wellhead housing which contains casing hangers, each  
23                  secured to a string of production casing that extends  
24                  into the well. The tree mounts on top of the wellhead  
25                  housing. The tree has a vertical bore and a horizontal  
26                  or lateral production flow outlet. A tubing hanger lands  
                       in the bore of the tree and is secured to a string of  
                       production tubing extending through the casing hangers  
                       and into the well. The tubing hanger has a lateral flow

1 passage that registers with the lateral passage of the  
2 horizontal tree.

3 A plug, normally wireline retrievable, fits in the  
4 vertical passage of the tubing hanger above the  
5 horizontal passage. A tree cap fits above the tubing  
6 hanger in the bore of the tree. The tree cap may have a  
7 vertical passage within which the retrievable plug fits.  
8 A corrosion cap fits over the upper end of the tree.

9 A tubing annulus between the tubing and the casing  
10 communicates to a lower annulus port formed in the tree.  
11 This port leads through an annulus passage to an upper  
12 annulus port which extends into the bore of the tree  
13 above the tubing hanger seals. One or more valves are  
14 used to open and close the tubing annulus. The upper  
15 tubing annulus port communicates with a void that is  
16 located between the tubing hanger wireline plug and the  
17 seal of the internal tree cap.

18

19 summary of the Invention

20 A horizontal tree has a vertical bore and a  
21 horizontal production passage and is landed in a wellhead  
22 housing. A tubing hanger lands in the bore and has a  
23 vertical passage and a horizontal passage that aligns

1 with that of the tree. A retrievable first plug seals  
2 the vertical passage. A tree cap seals in the tree bore  
3 above the tubing hanger and has an axial passage. A  
4 retrievable second plug seals the tree cap passage. A  
5 vent port extends laterally through the tree cap between  
6 its axial passage and outer surface. A pair of seals on  
7 the second plug seal above and below the vent port. A  
8 tubing annulus passage communicates with the vent port  
9 and an annulus passage. The second plug serves as a  
10 second pressure barrier to the first plug and blocks the  
11 vent port. The annulus passage is sealed from  
12 communication with a void between the plugs.

13

14 Brief Description of Drawings

15 Figure 1 is a vertical sectional view of a portion  
16 of a horizontal tree constructed in accordance with the  
17 invention.

18 Figure 2 is an enlarged view of an upper portion of  
19 the horizontal tree of Figure 1.

20

1                   Best Mode for Carrying Out the Invention

2                   Referring to Figure 1, christmas tree 11 is of a  
3                   type known as a horizontal tree. It has a vertical or  
4                   axial tree bore 13 extending completely through it. A  
5                   set of grooves 15 are located on the exterior near the  
6                   upper end for connection to a drilling riser (not shown).  
7                   A removable corrosion cover 17 fits over the upper end of  
8                   tree 11. Tree 11 has a lateral production passage 19  
9                   that extends generally horizontally from bore 13 and is  
10                  controlled by a valve 20. Tree 11 will be landed on top  
11                  of a wellhead housing (not shown) which has casing  
12                  extending into a well.

13                  A tubing hanger 21 lands sealingly in bore 13.  
14                  Tubing hanger 21 is secured to tree 11 by a lock down  
15                  mechanism 22. A string of production tubing 23 extends  
16                  through the casing hangers (not shown) into the well for  
17                  the flow of production fluid. Production tubing 23  
18                  communicates with a vertical passage 25 that extends  
19                  through tubing hanger 21. A lateral passage 27 extends  
20                  from vertical passage 25 and aligns with tree lateral  
21                  passage 19.

22                  A wireline retrievable plug 29 will lock in vertical  
23                  passage 25, sealing the upper end of vertical passage 25.

1       Tubing hanger 21 has an upper seal 31 located above  
2       lateral passage 27 and a lower seal 33 located below  
3       lateral passage 27. Seals 31 and 33 seal to bore 13 of  
4       tree 11. Radial ports 35 in tubing hanger 21 are used to  
5       communicate hydraulic fluid to a downhole safety valve.  
6       These ports register with passages (not shown) formed in  
7       tree 11.

8           A tree cap 37 inserts sealingly into tree bore 13  
9       above tubing hanger 21. Tree cap 37 may have an axial  
10      passage 45 that extends through tree cap 37. Axial  
11      passage 45 has the same inner diameter as tubing hanger  
12      passage 25. A locking mechanism 47 similar to that of  
13      tubing hanger locking mechanism 22 is used to lock tree  
14      cap 37 to tree 11. Tree cap 37 is sealed to tree bore 13  
15      with an upper seal 49 and a lower seal 50. Lower seal 50  
16      has a smaller outer diameter than upper seal 49. Tree  
17      cap 37 has a depending neck 38 which inserts into a  
18      receptacle in the top of axial passage 25 in tubing  
19      hanger 21. Neck 38 does not seal in passage 25 so that  
20      a clearance therebetween is maintained.

21           As shown in Figure 2, a wireline retrievable crown  
22      plug 51 inserts into tree cap passage 45. Crown plug 51  
23      has body 55 which has a metal seal 57 secured to its

1 lower end. Seal 57 is a depending lip that seals against  
2 a tapered surface formed in tree cap passage 45. A vent  
3 port 70 extends laterally through internal tree cap 37  
4 from axial passage 45 to its outer surface. Body 55 has  
5 a pair of circumferential seals 58, 60 near its  
6 midsection above seal 57. Seals 58, 60 are located above  
7 and below a vent port 70 in passage 45, respectively.  
8 Vent port 70 extends laterally through the sidewall of  
9 tubing hanger 21.

10 Body 55 has a plurality of windows 59 which allows  
11 dogs 61 to protrude through. When in the outer locked  
12 position, dogs 61 will engage a groove 63 in tree cap  
13 passage 45. A cam member 65 is carried reciprocally  
14 within body 55. When in the lower position, cam member  
15 65 keeps dogs 61 in the outer locked position. When cam  
16 member 65 is pulled upward, it will allow dogs 61 to  
17 retract from groove 63. Cam member 65 has a profile 66  
18 on its upper end to allow engagement of a running and  
19 retrieval tool (not shown). A retainer 67 secures to the  
20 upper end of body 55 to retain cam member 65.

21 Referring again to Figure 1, a tubing annulus 81  
22 surrounds tubing 23 between tubing 23 and the smallest  
23 diameter string of casing (not shown). Tubing annulus 81

1       communicates with a lower annulus passage 83 that extends  
2       from tree bore 13 through the wall of tree 11 below  
3       tubing hanger seal 33. Lower annulus passage 83  
4       communicates with an upper annulus passage 85 that  
5       extends into tree bore 13 above tubing hanger seal 31 and  
6       below locking mechanism 47. Referring to Figure 2,  
7       passage 85 leads to the vent port 70 between both sets of  
8       upper and lower seals 49, 50 and 58, 60. Passage 85  
9       communicates with port 70 which joins axial passage 45.  
10      valves 87 are located in the tubing annulus passages 83  
11      and 85.

12           In operation, after the well is drilled and cased,  
13       horizontal tree 11 will be landed and connected to the  
14       wellhead housing (not shown). Tubing 23 will be lowered  
15       into the well on tubing hanger 21. Horizontal passage 27  
16       will orient with passage 19 when tubing hanger 21 lands  
17       in tree 11. Wireline plug 29 will be installed in tubing  
18       hanger vertical passage 25.

19           Preferably, crown plug 51 will be installed in tree  
20       cap 37 and pressure tested while tree cap 37 is at the  
21       drilling rig. Tree cap 37 will be lowered on a running  
22       tool on drill pipe. Crown plug 51 serves as a second  
23       pressure barrier to wireline plug 29 and blocks port 70.

1 Passage 85 does not communicate with a void located  
2 between plugs 29, 51 because of lower seals 50 and 57.  
3 Since neck 38 does not seal against vertical passage 25,  
4 the void between plugs 29, 51 communicates with bore 13  
5 below seal 50. However, seal 50 blocks communication of  
6 the void with annulus 81.

7 For a workover operation requiring the pulling of  
8 tubing 23, the operator may use a drilling riser and  
9 blowout preventer stack (not shown). After removal of  
10 corrosion cover 17, the drilling riser will connect to  
11 profile 15. Normally, a kill fluid will be circulated  
12 into the well which is heavier than the well fluid to  
13 prevent a blowout. The operator will land a running tool  
14 on and pull internal tree cap 37 and run back in with an  
15 inner riser string (not shown) which secures to the upper  
16 end of tubing hanger 21. Upper tubing annulus passage 85  
17 now communicates with an annulus surrounding the inner  
18 riser, which in turn communicates with choke and kill  
19 lines leading alongside the riser back to the drilling  
20 rig. The operator will pull wireline plug 29 with a  
21 wireline tool. A port (not shown) at the lower end of  
22 tubing 23 will be opened to communicate the interior of  
23 tubing 23 with tubing annulus 81. This may be done with

1           a wireline tool in a conventional manner. With  
2 production valve 20 closed and tubing annulus valve 87  
3 open, the operator can pump down the inner riser, down  
4 tubing 23 and back up tubing annulus 81. The annulus  
5 fluid circulates through annulus passages 83, 85 up tree  
6 bore 13 and through the choke and kill lines to the  
7 surface. After the kill fluid has been placed in the  
8 well, the operator may pull production tubing 23.

9           Under some circumstances, an operator may wish to  
10 achieve wireline intervention into tubing 23 without  
11 killing the well and without using the drilling riser.  
12 Wireline access is achievable with the well under flowing  
13 conditions. A wireline riser (not shown) will be  
14 installed in the upper portion of passage 45 of tree cap  
15 37. The operator can use a wireline tool to engage crown  
16 plug 51. The operator will retrieve plugs 29 and 51 in  
17 a conventional manner to perform the wireline  
18 intervention.

19           The invention has several advantages. The tubing  
20 annulus has sealed barriers in the internal tree cap and  
21 the crown plug. The void between the plugs is isolated  
22 from the tubing annulus.

1           While the invention has been shown in only one of  
2       its forms, it should be apparent to those skilled in the  
3       art that it is not so limited, but is susceptible to  
4       various changes without departing from the scope of the  
5       invention.

6

1       I claim:

2       1. A wellhead assembly, comprising in combination:

3                 a christmas tree having an axial bore and a lateral

4                 production passage;

5                 a tubing hanger landed in the bore of the tree and

6                 having an axial bore and a lateral opening that aligns

7                 with the lateral production passage in the tree;

8                 a retrievable first plug landed in the bore of the

9                 tubing hanger above the lateral opening;

10                an internal tree cap assembly landed in the bore of

11                the tree above the tubing hanger;

12                a pair of seals axially spaced apart for sealing the

13                internal tree cap assembly in the bore of the tree;

14                a tubing annulus passage extending through the tree

15                to the bore in the tree above the tubing hanger;

16                a tubing annulus port extending through the internal

17                tree cap assembly from between the pair of seals to the

18                tubing annulus passage; and wherein

19                a lower seal of the pair of seals separates the

20                tubing annulus port from the first plug.

1       2. The wellhead assembly of claim 1, further comprising  
2       a retrievable second plug landed in an axial passage of  
3       the internal tree cap assembly.

4

5       3. The wellhead assembly of claim 1 wherein the  
6       internal tree cap has an axial passage and the tubing  
7       annulus port extends from an exterior surface of the  
8       internal tree cap to the axial passage; and wherein the  
9       wellhead assembly further comprises:

10            a retrievable second plug landed in the axial  
11          passage of the internal tree cap assembly and blocking  
12          the tubing annulus port; and

13            a seal on the second plug for sealing the axial  
14          passage above the tubing annulus port.

15

16       4. The wellhead assembly of claim 1 wherein the  
17       internal tree cap has an axial passage and the tubing  
18       annulus port extends from an exterior surface of the  
19       internal tree cap to the axial passage; and wherein the  
20       wellhead assembly further comprises:

21            a retrievable second plug landed in the axial  
22          passage of the internal tree cap assembly and blocking  
23          the tubing annulus port;

1           an upper seal on the second plug for sealing the  
2           axial passage above the tubing annulus port; and

3           a lower seal on the second plug for sealing the  
4           axial passage below the tubing annulus port.

5  
6       5. The wellhead assembly of claim 1 wherein the  
7           internal tree cap has an axial passage and the tubing  
8           annulus port extends laterally through a sidewall of the  
9           internal tree cap from an exterior surface to the axial  
10          passage; and wherein the wellhead assembly further  
11          comprises:

12           a retrievable second plug landed in the axial  
13          passage of the internal tree cap assembly and blocking  
14          the tubing annulus port; and

15           a seal on the second plug for sealing the axial  
16          passage above the tubing annulus port.

17  
18       6. A wellhead assembly, comprising in combination:  
19           a christmas tree having an axial bore and a lateral  
20          production passage;

21           a tubing hanger landed in the bore of the tree and  
22          having a lateral opening that aligns with the lateral  
23          production passage in the tree and an axial bore;

1           a retrievable first plug landed in the bore of the  
2           tubing hanger above the lateral opening;  
3           an internal tree cap landed in the bore of the tree  
4           above the tubing hanger and having an axial passage;  
5           upper and lower seals located between the internal  
6           tree cap and the tree;  
7           a vent port extending through the internal tree cap  
8           from an exterior sidewall to the axial passage between  
9           the upper and lower seals;  
10          a tubing annulus passage in the tree which registers  
11          with the vent port;  
12          a retrievable second plug landed in the axial  
13          passage of the tree cap; and  
14          seals on the second plug which seal a junction of  
15          the vent port with the axial passage.

16

17       7. The wellhead assembly of claim 6 wherein the seals  
18       on the second plug comprise upper and lower seals on the  
19       second plug which locate above and below the vent port.

20

21       8. A method for providing a tubing annulus access in a  
22       wellhead assembly having a tree, a tubing hanger and a  
23       first plug, comprising:

1                   providing an internal tree cap with an axial passage  
2                   and a lateral vent port extending through a sidewall to  
3                   the axial passage, the vent port registering with an  
4                   annulus passage extending through the tree from the  
5                   tubing annulus;

6                   landing and sealing the internal tree cap in the  
7                   tree; and then

8                   landing and sealing a second plug in the internal  
9                   tree cap adjacent to the vent port such that the second  
10                  plug seals the vent port from communication with the  
11                  axial passage.

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The  
Patent  
Office

16

Application No: GB 9727333.8  
Claims searched: 1-8

Examiner: R L Williams  
Date of search: 27 May 1998

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1F (FJB)(FJC)(FJR)(FLE)

Int Cl (Ed.6): E21B 33/04,33/043,34/04

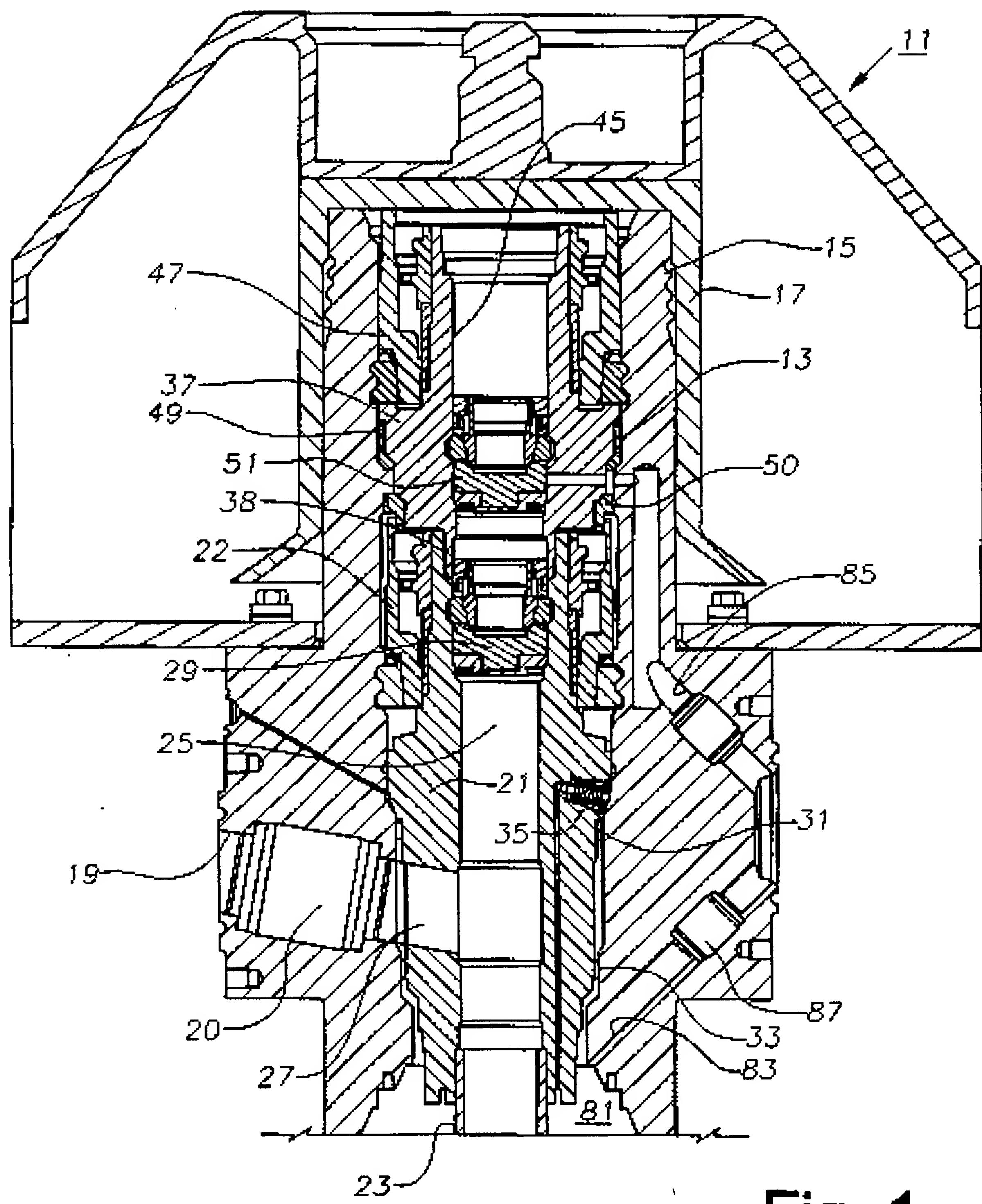
Other: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2,292,571 A	ABB Vetco Gray Inc	1,6 and 8
A	US 5,575,336	M G Morgan	1,6 and 8

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

1/2



**Fig. 1**

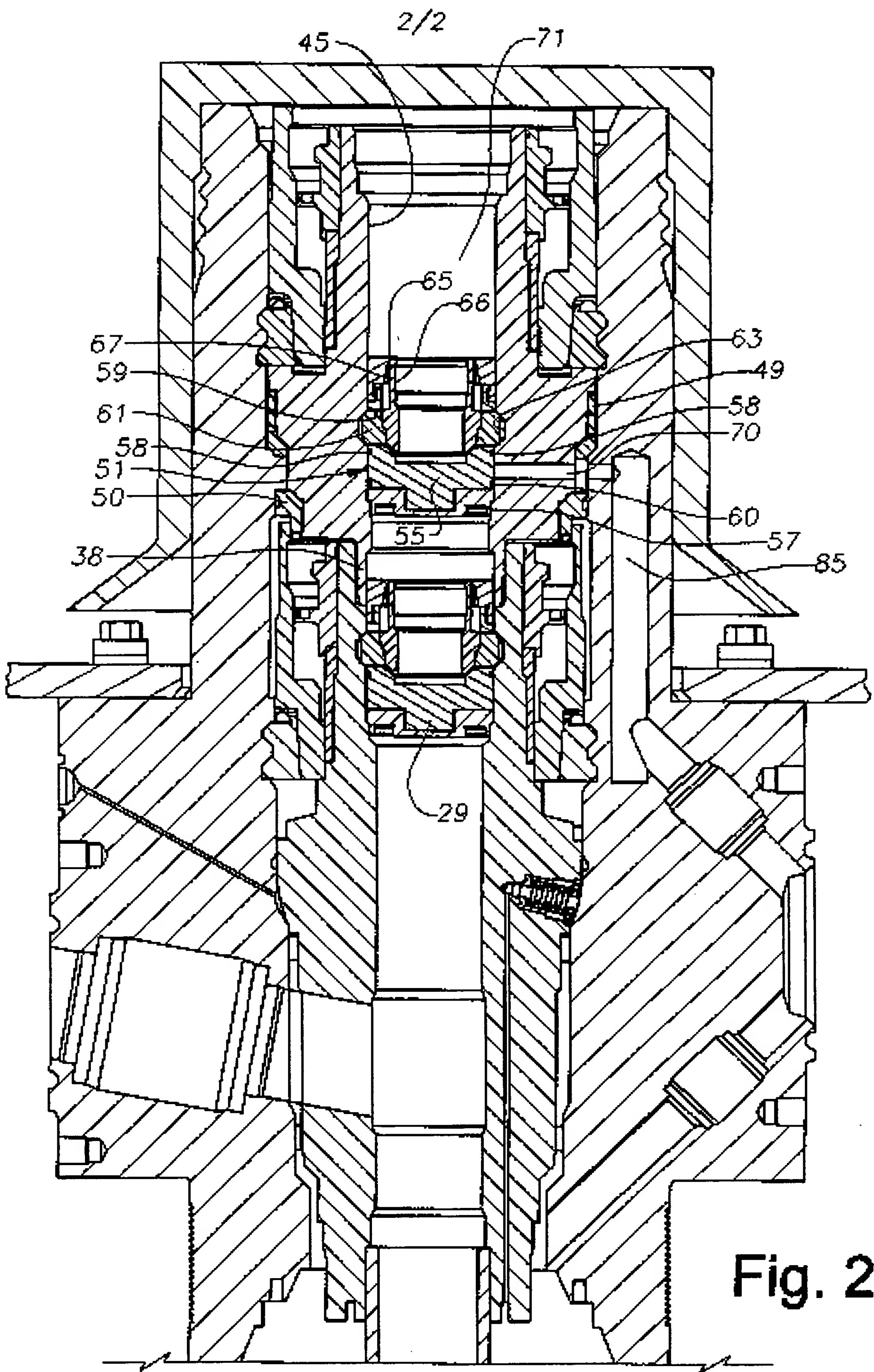


Fig. 2